VOL. 2 NO. 12 December 1985

COMPUTER DIGEST

A NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

ATTENUATORS AND MINIMUM LOSS PADS

Using your computer to simplify design problems.

DOUBLE DENSITY THE PERCOM WAY

Modifying your Model I double-density adapter

A GERNSBACK PUBLICATION

TUNING THE 1541

How to get your Commodore disk drive back on track

BUILDING A MODEM

Part II, the conclusion.

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ON THE COVER

It's that time of year once again, and the message on our cover display was generated by Fontrix™. We'll be covering that, and other graphics software in an upcoming issue. The computer you see passing on our wishes for a happy holiday is the SAM 3001 from HiTech International. It's one of the first of the AT-compatibles to hit the market. For a review on the machine, turn to page 4.

COMING NEXT MONTH

We've got a great story lined up on everything you want or need to know about hard disks. Then we're going to begin a two-part article on how to use your computer to help design loudspeaker enclosures. And to round out a great issue, you'll get an in-depth article on the ubiquitous 555 timer. Don't miss it!

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Gernsback Publications, Inc.
200 Park Ave. South
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Chairman of the Board:
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Larry Steckler
Publisher

EAST/SOUTHEAST
Stanley Levitan
Radio-Electronics
200 Park Ave. South
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212-777-6400

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
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540 Frontage Road—Suite 325
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LETTERS

Mor-On Hackers

I read your last letters section with great interest. It seems that people can always find a way to justify anything they do, can't they?—R.W., Denver, CO.

They can TRY to. But the wheel keeps right on turning, and wait until they get caught and have to stand before a judge and face the penalties. Suddenly the glamor and romance vanishes as they have to dig down and pay fines, court costs, lawyers fees, etc. The "proud parents" of what the newspapers labelled "Computer Wiz Kids" won't be so proud when they have to shuck out the big bucks. If only these people would think ahead!

"Ham" A Nasty Word?

How would you feel about not calling yourself a Ham Operator anymore if some amateurs were violating the FCC rules? That's why I want to keep calling myself a "Hacker!"—J. R., Tulsa, OK.

I am proud of my ham ticket but if the same sort of thing occurred, I'd go back to calling myself an "Amateur Radio Operator." Language keeps changing. "Gay" once meant "happy." If you felt happy, would you tell all your friends you were gay?

Everybody Does It!

I really don't see what the fuss is all about. Everybody hacks at one time or another, in one way or another. Maybe some more than others, but what's the big deal?—M. L., Cranbury, NJ.

First of all, everybody does **not** *do it! I don't do it; neither do a lot of other respectable computer experimenters that I know. And the "fuss" as you call it is twofold. For one thing it's illegal. The other point is that it's giving us all a bad name.*

Thank You!

Okay. It took two of your editorials to convince me, but I've seen the point and you're right. And it took guts on your part to stand up for that right. You are to be complimented. Now suppose you peer into your crystal ball and tell us what's liable to happen if things go on like this.—S.W., Fairbanks, AK.

Thank YOU, S. W. What I can foresee is a Government examination on the use of computers before you're allowed to use one. An examination that goes into the do's and don'ts so that if you elect to violate the law and get caught, you won't be able to say "Hey! I didn't know." And I can see much tighter controls on modems too, with Government agencies freely tapping in to monitor and dropping in on violators to confiscate their equipment.◀CD▶

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

DISK-DRIVE/TAPE BACKUP COMBINATION, consists of the model *AT HD* disk drive and the model *QIC-60 AT* tape backup unit.

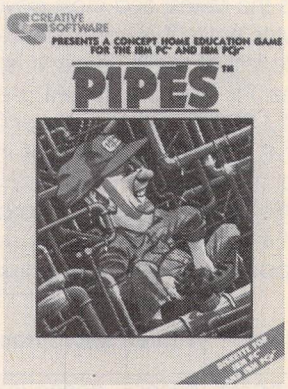
The model *AT HD* is a Winchester hard disk drive for the IBM PC-AT with a formatted capacity of 20 megabytes. The model *QIC-60 AT*, an internal streaming tape-backup unit, provides increased security that data will not be lost through user error or mechanical failure.

The model *AT HD* and *QIC-60 AT* sell for a combined suggested retail price of $3290.00.—*Tencar, Inc.*, 6225 Cochran Road, Solon (Cleveland), OH 44139-3377.

CIRCLE 11 ON FREE INFORMATION CARD

EDUCATIONAL GAME, *Pipes*, teaches children the concepts of spatial relationships and economics. The object of the game is to create a water network, using the least amount of pipe and money. The player must connect all the houses in town to the main water supply. After hooking up all the houses, the player turns on the water supply to make sure that there are no leaks. The VIC-20 version of *Pipes* was the 1983 CES Software Showcase award winner for "Best Home Education."

Pipes is available for the IBM/*PCjr* and Commodore *64* at a suggested retail price of $29.95. All versions are on disk.—*Creative Software*, 230 East Caribbean Drive, Sunnyvale, CA 94089.◀CD▶



CIRCLE 12 ON FREE INFORMATION CARD

HiTech's SAM 3001

PAT O'BRIAN

The AT-compatibles are coming! Here's a look at one of the first to hit the market.

■The IBM PC/AT received great critical acclaim when it was introduced a little over a year ago, mostly for its unmatched price/performance ratio. IBM's pricing policy was obviously intended to beat the clone competition even before it started.

The public, however, did not regard the AT as highly—at least if you believe the sales figures. The extra speed was impressive, but not enough to warrant buying a new machine. And then there was the hard-disk drive that created reliability problems. If not for the IBM Local Area Network, the machine could have headed the way of the Junior. The software writers also were—and still are—slow in taking advantage of the AT's impressive capabilities.

All that may change now, because the AT-compatibles are on the way. And that's sure to make even IBM's machine more popular than ever. We had the opportunity to examine one of the first AT-compatibles to hit the market: the Sam 3001 from HiTech International (1180 Miraloma Way, Sunnyvale, CA 94086 (408) 738-0601). You might remember HiTech as the manufacturer of the Sam 2001 XT-compatible computer kit that was featured in July's **Radio-Electronics.**

What the PC/AT offers

Before we look at what the SAM 3001 has to offer, let's see what IBM's machine does. The IBM PC/AT is not the fastest and most powerful computer you can buy, but it is the fastest and most powerful IBM personal computer. While it is compatible—for the most part—with the rest of the PC family, it is certainly an improved machine. For example, the AT uses the faster and more powerful 80286 microprocessor (which runs easily at 6 MHZ, has a true 16-bit data bus interface, can address 16MB of memory, and is upward compatible with the PC's 8086). The AT's system board can hold up to 512K of RAM and offers 8 expansion slots. The disk controller can support fixed- or floppy-disk drives, including the new higher capacity (1.2 megabyte) floppy-disk drives. A CMOS clock/calendar memory with battery backup was added to the main board. CMOS RAM on the clock chip—instead of on-board switches—holds most of the system-configuration information. The keyboard is much better than anything else IBM has offered. The AT's BIOS (*B*asic *I*nput/*O*utput *S*ystem) is 4 times bigger than the XT's. Some of the reasons for that is that it includes the hard-disk BIOS instead of relegating it to the controller card; the floppy-disk BIOS can handle various media and drive types, and multitasking-support functions were added.

Can a compatible be better?

You might expect the clone-makers to try to out-do IBM. And that's exactly what HiTech tried to do with the SAM 3001. And—as shown in the table below—for the most part, they succeeded.

The Motherboard (manufactured by Faraday Electronics of Sunnyvale, CA) comes standard with 640 KB of RAM and is expandable on-board to 1 MB. You'd have to tie up an expansion slot on the AT if you wanted 1 MB of RAM. Two serial ports and one parallel port are included on the main board, so they don't tie up any slots. What's more, each serial port can be configured for either the RS-232 or RS-422 standards.

The SAM 3001 runs PC-DOS 3.0, as well as MS-DOS 3.1 and XENIX. Of course, as with any other PC-compatible, the SAM 3001 does not support IBM BASIC, but it will run the similar GW-BASIC.

A hercules-type graphics card, which includes a parallel port, comes standard with the SAM 3001, as does a 20 MB hard-disk drive.

To sum up the SAM 3001, it's basically an AT with the added benefits of extra on-board memory and serial and parallel I/O ports, a monochrome/graphics card, and greater expandibility. We found the machine to be compatible with IBM's; it will even run IBM's advanced diagnostics program. We are not without complaints, however. We had problems with the board's power-on reset, and with the configuration-memory. A new set of ROM's cleared up the configuration-memory problem, and a call to HiTech cleared up the power—on reset problem. (It really wouldn't have been a much of a problem if the documentation supplied with the SAM 3001 was better—a change in the reset circuit was never documented.)

Another complaint was with the floppy-disk drive. It was extremely loud, and we were victimized by frequent data errors. HiTech has realized that problem, however, and has switched to Mitsubishi as its drive supplier.◀CD▶

	Price	Microprocessor	RAM	On-board RAM (max)	Disk Drives	I/O Ports	Display Adapter	Empty Slots
IBM PC/AT	$3995	80286 (6 MHz)	256 KB	512 KB	1.2 MB Diskette	None	None	7
IBM PC/AT Enhanced	$5795	80286 (6 MHz)	512 KB	512 KB	1.2 MB Diskette 20 MB Fixed	1 Serial 1 Parallel	None	6
HITECH SAM 3001	$4395	80286 (6 MHz)	640 KB	1024 KB	1.2 MB Diskette 20 MB Fixed	2 Serial 2 Parallel	Hercules-type mono/graphics	7

ATTENUATORS AND MINIMUM-LOSS PADS

Larry Friedman

■"Attenuators" and "Minimum Loss Pads" is a program that quickly calculates the resistance values for H and T attenuators and the values for minimum-loss L-matching networks. Simply key in the input and output impedances and the desired amount of loss. The screen will display the actual pad configuration and the required resistance values. If you haven't the displayed resistor values on hand, you get a chance to recycle the program and make minor changes in loss or impedance until you come up with a pad using resistor values you happen to have.

To make the program truly universal, it is written in "Timeshare Basic," which means it should run on every computer without modification of any kind except perhaps for the CLS (CLEAR SCREEN) function. If your own computer uses something other than CLS for CLEAR SCREEN simply make the substitution. Otherwise, no further modification to the program should be required.

Because PRINT USING is not a universal BASIC function, resistance values are rounded off to their nearest integer value. For example, 144.3 ohms is displayed as 144; 144.6 ohms is displayed as 145 ohms. Rounding should have no practical effect on an attenuator. On the other hand, decibel loss is displayed in decimal values because that is the common and desired notation.

To make the screen and printer graphics universal, they are created from conventional ASCII symbols. Figures 1, 2 and 3 show how the three kinds of calculated pads are both printed and displayed. The negative (−) symbol in front of some of the resistor values in Figure 1 indicate that the impedance on that side of the circuit is less than on the opposite side. Note from the illustrations that two different ways are used to indicate input and output impedances. You can substitute either kind of labelling in the program since both employ universal characters.

Depending on the kind of computer used, the graphic display will either fill most of the screen or appear scrunched on the left. This is caused by writing the program so it will run on all computers regardless of the display's column width; also, screen dumps to a printer will print on every kind of printer used with personal computers, from conventional 80/100 column models to pocket printers which use narrow calculator-type tape.◀●▶

```
LOSS =  10 DB
    261          -14
----XXXX--------XXXX----
           !
           !
           X
           X    211
           X
           !
           !
----XXXX--------XXXX----
    261          -14

 600 OHMS IN    150 OHMS OUT

DO IT AGAIN? (Y OR N)?

LOSS =  3 DB
    474
----XXXX----------------
           !
           !
           X
           X    53
           X
           !
           !
------------------------

Z= 500 -->     <-- Z= 50

DO IT AGAIN? (Y OR N)? .
```

```
     103
----XXXX----------------
           !
           !
           X
           X    1703
           X
           !
           !
------------------------

Z= 600 -->     <-- Z= 600

DO IT AGAIN? (Y OR N)? .

LOSS IS  15.7948  DB
```

FIG. 1—THIS IS HOW the three types of pads are both printed and displayed. Please refer to the text for additional information.

```
10 REM ATTENUATOR PADS
20 REM      BY
30 REM LARRY FRIEDMAN
40 REM CALCULATES H,T,L PADS
50 REM  IN UNIVERSAL BASIC
60 CLS
70 PRINT TAB(10) "1 = H PAD"
80 PRINT TAB(10) "2 = T PAD"
90 PRINT TAB(10) "3 = L PAD"
100 INPUT "ENTER PAD TYPE (1, 2 OR 3) ";T
110 CLS
120 IF T=3 GOTO 3000
130 IF T>3 GOTO 60
140 INPUT "INPUT LOSS IN DB "; DB
150 N=EXP((DB)*0.230259)
160 INPUT "INPUT Z IN";Z1
170 INPUT "INPUT Z OUT";Z2
180 R3=(2*SQR(N*Z1*Z2))/(N-1)
190 R1=Z1*((N+1)/(N-1))-R3
200 R2=Z2*((N+1)/(N-1))-R3
210 CLS
220 IF T=1 GOTO 1000
230 IF T=2 GOTO 2000
240 CLS
250 INPUT "DO IT AGAIN? (Y OR N)";Q$
260 IF Q$="Y" GOTO 110
270 CLS
280 END
1000 PRINT "   "INT(R1/2+0.5) TAB(16);INT(R2/2+0.5)
1010 PRINT "----xxxx--------xxxx----"
1020 PRINT TAB(12)"!":PRINT TAB(12)"!"
1030 PRINT TAB(12)"X"
1040 PRINT TAB(12)"X  " ;INT(R3+0.5)
1050 PRINT TAB(12)"X"
1060 PRINT TAB(12)"!":PRINT TAB(12)"!"
1070 PRINT "----XXXX--------XXXX----"
1080 PRINT "   "INT(R1/2+0.5) TAB(16) INT(R2/2+0.5)
1090 PRINT
1100 PRINT Z1 "OHMS IN" TAB(14) Z2 "OHMS OUT"
1110 PRINT
1120 GOTO 250
2000 PRINT "    "INT(R1+0.5)
2010 PRINT "----XXXX----------------"
2020 PRINT TAB(12)"!":PRINT TAB(12)"!"
2030 PRINT TAB(12)"X"
2040 PRINT TAB(12)"X  "INT(R3+0.5)
2050 PRINT TAB(12)"X"
2060 PRINT TAB(12)"!":PRINT TAB(12)"!"
2070 PRINT "------------------------"
2080 PRINT
2090 PRINT "Z="Z1"-->" TAB(14) "<-- Z="Z2
2100 PRINT
2110 GOTO 250
3000 INPUT "INPUT LARGER Z";Z1
3010 INPUT "INPUT SMALLER Z";Z2
3020 IF Z2>Z1 PRINT "ERROR":GOTO 3000
3030 R1=SQR(Z1*(Z1-Z2))
3040 R2=(Z1*Z2)/R1
3050 R3=R2
3060 L=20*LOG(SQR(Z1/Z2)+SQR((Z1/Z2)-1))/2.30259
3070 CLS
3080 PRINT "LOSS IS ";L" DB"
3090 GOTO 2000
```

DOUBLE DENSITY THE PERCOM WAY

Can you modify your Model I Double Density Adapter? Sure you can!

GARY FOSTER

■If you bought the Radio Shack Model I Double Density Adapter Kit to increase disk storage on your old Model I you soon realized that you were all alone in the world. All your Model I owning friends had done the smart thing. They bought the PERCOM Doubler which let them use all the neat new operating systems on the market. You and I were stuck with Model I Double Density TRSDOS and little else. You may have decided to make the best of a bad deal and live with your double density (of a sort), but I spent a lot of time looking at my NEWDOS80 Version 2 manual with all those PDRIVE command options, references to "double density" and so forth.

Circuit descriptions

A comparison of the schematics showed me that the same double density disk controller chip was used on both adapter boards. The only differences between the two were the method of addressing the bit which selected single or double density and the method of enabling write precompensation. On the Radio Shack version, density selection is done by using the upper three (3) bits of data written to the sector write register at address 37EEH (A1 is high and A0 is low). See figure 1 for the schematic of the circuit. A normal write to the sector-write register will contain zeroes in data bits D5-D7 (there are no sectors greater than 31). This inhibits the density select decoder (U10) by placing a logic high on the G2A input. A write to the sector write register with any of D5-D7 active (D5'-D7' low) will enable the select decoder (U10) and allow a density change to occur. Remember that all data lines on both adapter boards are present only in their inverted state. See Table 1 for the control functions of each combination of D5-D7. Notice that write precompensation is enabled by the software.

The PERCOM method of density selection is entirely different (as we already knew). This circuit, shown in figure 2, clocks a D-type flip-flop when address lines A1 and A0 are low (this forms address 37ECH when the disk controller write enable line is active) and data lines D3-D7 are high. Data line D0 is then latched into the flip-flop to select single or double density. Address 37ECH is the address for the disk controller's command register. At first glance it appears that this method of addressing would cause the active controller to execute an unwanted (and possibly data-eating) instruction. A peek at the command summary for both controller chips quickly shows why this is not a problem: There is no instruction which corresponds to a high condition on datalines D3-D7. The active disk controller does not mind being given a meaningless command and we can safely swap active controller chips without fear. Write precompensation is always selected in double density with the PERCOM system.

D7	D6	D5	FUNCTION
0	0	0	No function
0	0	1	No function
0	1	0	Select drive side 0 N/A PERCOM
0	1	1	Select drive side 1 N/A PERCOM
1	0	0	Set double-density mode
1	0	1	Set single-density mode
1	1	0	Disable precompensation
1	1	1	Enable precompensation

TABLE 1—CONTROL FUNCTIONS of data lines for the Radio Shack Double-Density Adapter.

At this point you might say that this is an interesting comparison of two relatively simple address decoding schemes, but where's my double density?

Because of an interesting quirk on the part of the designers of the 7400 TTL family I found a reliable solution to my problem. The Radio Shack circuit board uses a 74LS10 integrated circuit (U11) in the enable circuit for the select decoder. This chip is a collection of three NAND gates with three inputs each. I was able

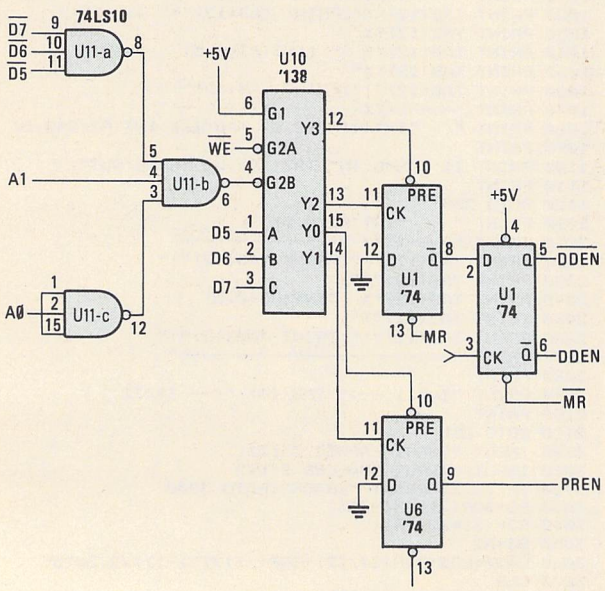


FIG. 1—SCHEMATIC DIAGRAM of the Radio Shack double-density adapter enable circuitry.

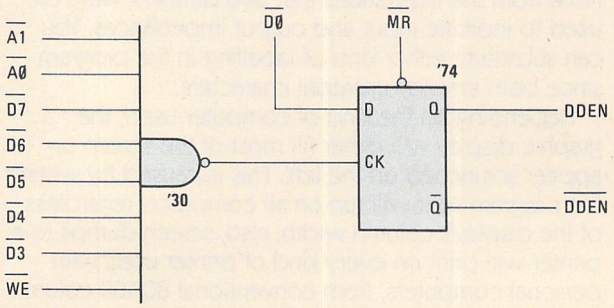


FIG. 2—REPRESENTATION OF PERCOM doubler enable circuitry.

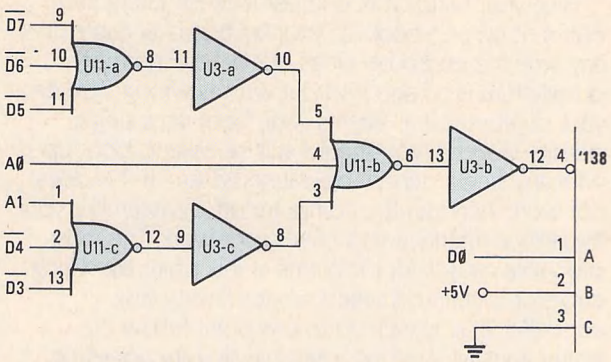


FIG. 3—RADIO SHACK'S double density adapter modified to perform as a Percom doubler.

to alter the address decoding scheme of the PERCOM Doubler to the circuit shown in figure 3 and then to figure 4. But this method requires three input NOR gates. By the grace of the 7400 TTL designers though we almost have our solution. There is a triple 3 input NOR gate chip (7427) that is pin compatible with its triple 3 input NAND gate cousin (7410). If we can replace our old 74LS10 chip with its NOR counterpart 74LS27 some of our work is already done by the PC board design. We will cut our expensive circuit board in fewer places! (See Fig. 5.)

While we are at it, we will change the circuit board to enable write precompensation any time double density is selected. We will also wire the interrupt lines from the controllers back into the circuit. This will make us fully compatible with the PERCOM Doubler. The best part is that the complete modification will only cost about $1.00 in parts and two hours in time.

As this will most assuredly void any warranty on your Radio Shack Double Density Adapter proceed with caution. We are going to remove your old Radio Shack Double Density board and, with a little static-free luck, turn it into a perfectly functional look-alike to a PERCOM Doubler. If you are not completely comfortable working on a $150 circuit board get a friend or pay someone to do this modification for you. You must remove an IC from your board, cut 10 traces, and connect jumpers in 14 places.

Modification procedure

First, take a hard look at everything you have stored in double density mode with your Radio Shack Double Density Adapter. Copy everything you want to keep onto single density TRSDOS diskettes. Once you modify your board you will no longer be able to read or write to your TRSDOS Double Density diskettes.

Next, assemble the following items:

1 74LS27 Integrated circuit
1 16 pin IC solder tail IC socket
1 Low heat soldering iron
1 Short length of 22 ga. solder or equivalent
24-in. of 28 ga. wirewrap wire or equivalent
1 Pair of small diagonal cutting pliers
1 Pair of small needle nose pliers or tweezers

Disassemble your expansion interface and locate the disk controller piggy-back board. It should be the only small circuit board you see. Carefully remove the circuit board without bending any pins. Be patient and rock it back and forth until it comes free from the socket. Hold the board with your fingers on the edges (don't touch the IC's any more than you can help). Turn the board so that the component side is facing you with the Tandy Corp. printing in the upper right hand corner. The IC on the very bottom (just below U3) labelled U11 is our target. Using soldering iron with a low heat element and an IC removing tip, desolder and remove U11. (See Fig. 6.) Another suitable method is to cut the IC loose from its pins and discard it. Then heat each solder pad in turn and, with a small pair of needle nose pliers or tweezers, remove the metal scraps from the hole. Carefully clean up your solder flux and clean out the holes, then solder an IC socket into the holes where the IC used to be. Using a very sharp razor blade, or an Exacto knife cut the following traces:

between U8 pin 9 and U6 pin 9
between socket header pin 39 and ground
between U11 pin 1 and U11 pin 13
between U11 pin 8 and U11 pin 5
between U11 pin 3 and U11 pin 12
between U11 pin 11 and U10 pin 1
between U11 pin 10 and U10 pin 2
between U11 pin 9 and U10 pin 3
between U11 pin 6 and U10 pin 4

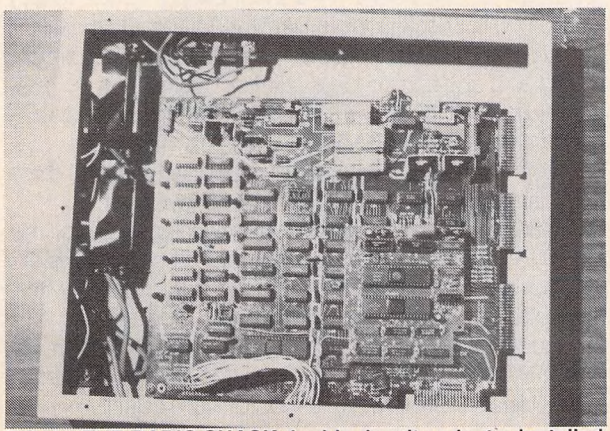


FIG. 4—THE RADIO SHACK double density adapter installed in the LNW System expansion board.

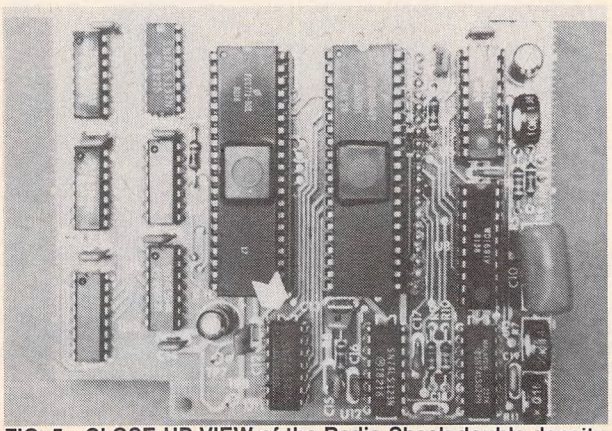


FIG. 5—CLOSE-UP VIEW of the Radio Shack double density adapter. Arrow points to U11, the IC we're going to replace.

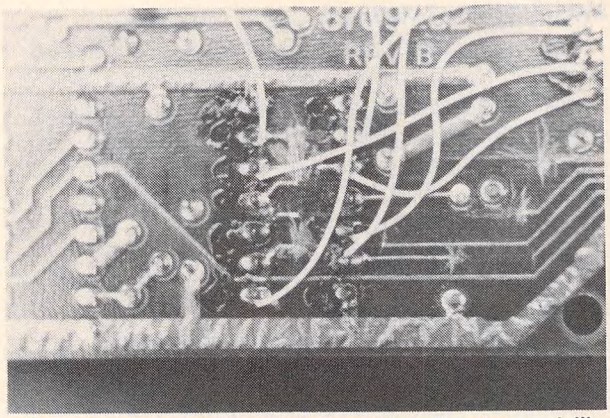


FIG. 6—WIRING MODIFICATIONS to U11. Notice that we deliberately make large gaps in the trace cuts to ensure a good cut.

With a soldering iron on low heat use #28 gage wire wrap wire to make the following jumper connections:

between U3 pin 39 and U4 pin 39
between U3 pin 39 and socket header pin 39
between U10 pin 2 and +5 volts
between U10 pin 3 and ground
between U10 pin 1 and U9 pin 6
between U9 pin 5 and U3 pin 7
between U11 pin 2 and U3 pin 11
between U11 pin 13 and U3 pin 10
between U11 pin 12 and U9 pin 9
between U9 pin 8 and U11 pin 3
between U11 pin 8 and U9 pin 11
between U9 pin 8 and U11 pin 5
between U11 pin 6 and U9 pin 13
between U9 pin 12 and U10 pin 4

Reassembly and testing

Carefully insert a 74LS27 IC in the socket you installed. Be sure that the notch in the IC package is oriented properly and that no pins are bent or broken (even though we have 16 on this one, we don't have any to spare). Just as cautiously as you removed it, install the double density board back in its socket on the expansion interface board. Be certain that you install the adapter board in the same orientation as it was before. (See Fig. 7.)

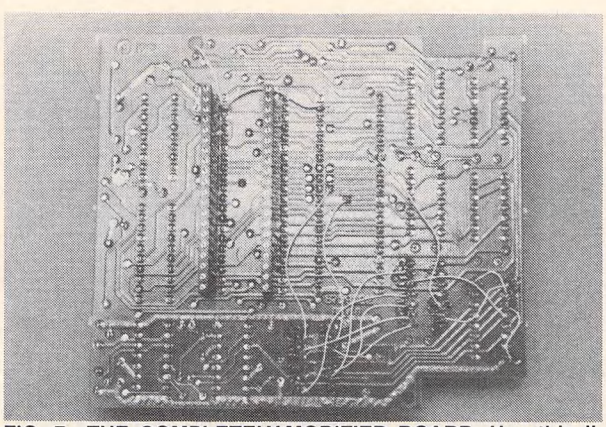


FIG. 7—THE COMPLETELY-MODIFIED BOARD. Use this illustration as a guide while working on your own board. Leave as little slack in jumper wires as possible.

Give your handiwork one last look for safety, then button it up and hook up your keyboard-EI cable. If at any time the computer does not behave normally quickly turn it off and find out what is wrong. Turn on your computer. If all seems well, boot up a single density diskette; you should still be able to boot up with any single density operating system. If this does not work then turn the computer off, disassemble your Expansion Interface and check your work. The most probable causes for problems at this point are wiring errors or a static-damaged single-density disk controller. If all is well up to this point follow the instructions for creating a double density operating system diskette. NEWDOS80 Version 2 will allow you to do this with the PDRIVE command. Your computer should now have written double density to a diskette and verified it correctly. If so, then you are through except for the rather pleasant task of copying everything in your software library onto your new double density diskettes. If it does not work in double density but appears to be okay in single density, you have probably damaged your double density

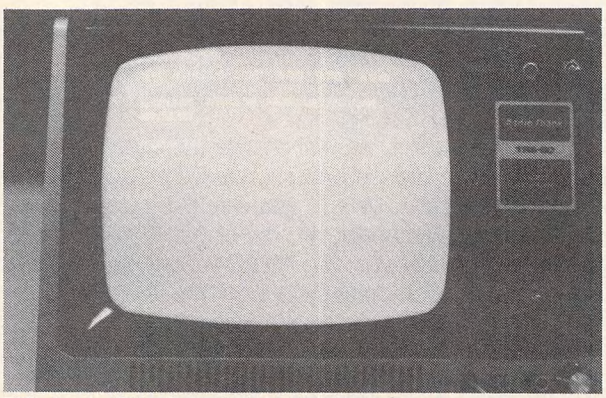


FIG. 8—A JOY TO BEHOLD! NEWDOS/80 with ever so much memory available for only the cost of a 29 cent IC!

controller chip. (See Fig. 8.)

If the wiring is okay after you have thoroughly rechecked it, try replacing this chip and try again.

Since this chip is easily subject to damage, and since its cost is so low, there should be little or no hesitation in suspecting it, and if necessary, switching it for a new one. It's certainly a small enough price to pay.

The Radio Shack Double Density Adapter is a nice addition to the TRS80 Model I. It is a well made circuit board and appears to be a reliable design. It is certainly capable of withstanding rigors of this modification. When Tandy released this device however they chose to make it incompatible with the popular operating systems produced by other companies. The great majority of good software for the TRS80 Model I is on non-TRSDOS operating systems. If you bought the Radio Shack and are not satisfied with the options available to you, then this modification is for you. I have used this modification on my system with NEWDOS80 Versions 1 and 2 for several months with no bad side effects; it should work equally well on any double density operating system which uses the PERCOM Doubler. ◀CD▶

TUNING THE COMMODORE 1541

How to align and time the 1541

JIM STEPHENS

■While the Commodore 1541 disk drive is a marvel of electronic hardware, it has its flaws. Sooner or later it will require servicing. The following is a description of what you might try before sending it off on a long and expensive vacation.

One day my 1541 began to blink slightly while trying to load my favorite program and this led me to believe a problem might be brewing. Since the 1541 doesn't give up easily, it continued to re-read the data and finally load the required blocks from the disk. The blinks, which meant mis-read data bits, kept getting worse until one day, it gave up and refused to load those programs at all. Often, it would get completely through the load and reset itself back to the ready prompt screen.

On newly-written programs, where I had just formatted the diskette, there was no problem. The light stayed on continuously and the programs loaded fine. If I tried to load a piece of commercial software or a program from a friend's machine, things got really bad. After losing a complete database file disk from which I couldn't recover, I decided that now was the time to fix it. Fix what? I wasn't quite sure.

I found that there are three main mechanical malfunctions that could cause blinking lights and mis-read data. These are a dirty read head, a slow disk speed, and a misaligned head to the data track. Since these problems are mainly mechanical, they can be fixed by the average mechanical tinkerer. However, poking around inside a delicate piece of equipment such as the 1541 with a screwdriver does require some experience and is recommended only to those who feel capable and confident.

Case disassembly and head cleaning

Occasional program glitches and garbage on the screen without a blinking red light could mean a dirty read head. Rather than pay a small fortune for a head cleaning kit, use a cotton swab slightly dampened with alcohol. The only problem is getting at the head in order to clean it.

The drive case is formed of an upper and lower half. The top is held together by four screws through the bottom. Unplug the 1541 from the power cord and serial buss. Turn the drive over and remove the four screws. Then re-invert the drive carefully and remove the top cover. You will see part of the circuit board and some of the diskette guides. The rest is covered by a steel cover. This interior cover is attached by two small screws on the left side of the drive's metal frame. The right side is secured by two small detents that hold the cover in place. Remove this cover and you can view the rest of the circuit board and drive mechanics. Also, you can easily see the read head near the center below the circuit board.

The head is the small white square towards the bottom of the case that is recognizable by the black line that crosses it from left-to-right as shown in Figure 1. Most people think that the head is the gizmo that rides on top of the diskette. This is only a small piece of white felt that holds the diskette surface close to the head. The data is read from the bottom of the diskette, not the top.

Using a good-quality cotton swab which is slightly damp with alcohol, you can gently clean the surface of the head at this point. Make sure you don't soak the swab, or you may flood the head causing more problems. You'll be surprised to find a generous amount of grime on the swab if you have used your drive extensively. Many times, this cleaning is all that is required to get the drive back to normal operation. You may want to try a program or two before proceeding further. Always replace the metal cover and case top before powering up.

Speed adjustment

The 1541 is tolerant of variations in diskette speed. Several things can cause the speed to vary. Drag on the drive mechanics, aging in the electronic drive components and slipping in the drive hub, to name a few. If the drive makes a low, screeching sound, the bearing that holds the plastic centering guide may have become dry. This bearing is located in the center and on top of the diskette guide arm. A small washer holds the shaft in place and lifts the centering guide when the door is raised. This shaft is directly over the center hole of the diskette when the disk is locked in place. A small drop of light machine oil on the washer will oil the bearing further down this shaft. Be sure that only one drop is used and any excess is wiped from the top of the assembly.

To actually check the speed of the drive, Commodore has included a dynamic speed indicator

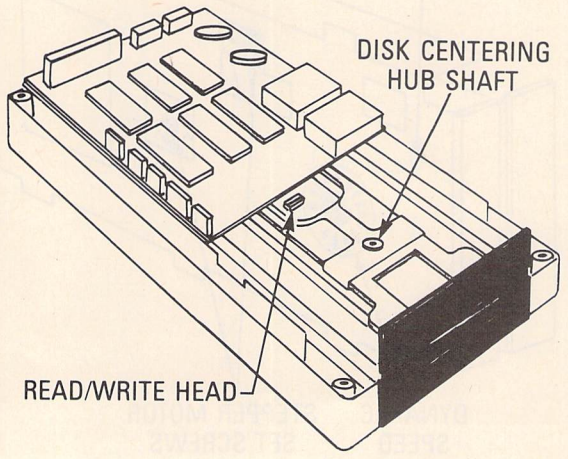


FIG. 1—LOCATING THE HEAD is easy if you follow the instructions and refer to the diagram above. Look for the small white square with the black line crossing it from left to right.

on the bottom of the diskette drive flywheel. To see this, it is necessary to remove the bottom of the plastic case.

You probably noticed that the drive is attached to the bottom of the case with six screws. After these are removed, the drive can be carefully turned on its side. The metal cover should be attached before this is done. The green indicator light is still attached to the case, so care should be used when the assembly is turned on its side in the case bottom.

Figure 2 shows the bottom of the drive assembly. The speed indicator is the pattern on the bottom of the drive flywheel. The pattern is used like the timing light on a car to set the correct rotation speed of the flywheel. The outside pattern is used for house wirings that operate on 60 Hz and the inside patern is for 50 Hz as found in England.

To check the speed of the drive, connect the drive to the computer and load a program while the assembly is on its side. Be careful since many components are exposed and should not be touched while the drive is operating. Shine a small fluorescent lamp on the flywheel with other lights in the room out. The outer pattern on the flywheel should appear stationary. While a small amount of movement can be tolerated, it should be corrected. If the pattern seems to be rotating rapidly, some adjustment to the speed control will be required.

The speed control is located under the metal case below a small access hole above and to the left of the flywheel. It is a small potentiometer with a screw that is held securely by a green glue. A small screwdriver inserted into this screw and turned will either speed up or slow down the pattern. Turn the screw until the pattern stops rotating and remains still. You may have to try several times. You should *not* have to turn the screw more than 1/16th inch in either direction. If you do, there may be other problems causing the incorrect speed. If you cannot get the pattern perfectly still, get as close as possible.

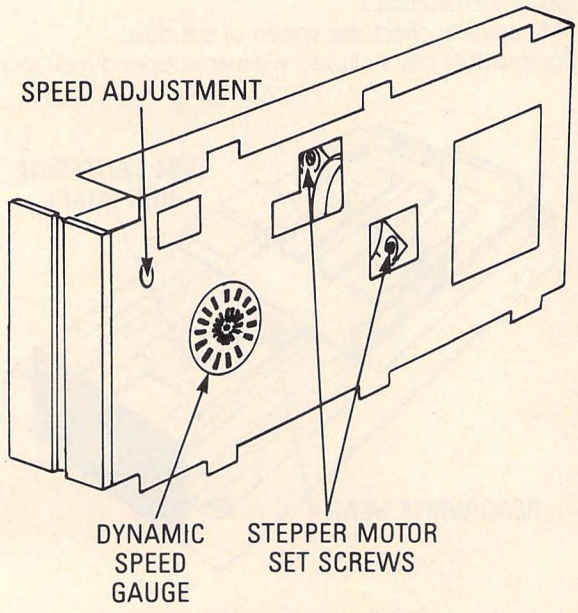


FIG. 2—BOTTOM OF THE DRIVE ASSEMBLY. The speed indicator is the stroboscopic pattern on the bottom of the drive flywheel. Outer pattern is for 60 Hz, inner is for 50 Hz.

Read-write head alignment

The last and most-probable cause of problems is a misaligned head. The head has a tendency to slip from the correct path over the disk track after awhile. Since the diskette has some 35 tracks and only about one inch of lateral space around the disk, each track can be no more than 1/32 inch wide. Any small deviation can make the head appear to be badly misadjusted. A deviation of even 1/64th inch and the head would be half way off the track.

The problem of course, is to get it back on track and this is no simple task without test equipment. There is a way however, It's called "trial and error." We can do it, but it may take several tries.

Figure 2 shows the bottom of the main drive assembly. Note that the flat stepper motor is to the right of the patterned flywheel that we just used. This stepper motor controls the position of the head. This motor was meant to be moved to correct any small error in head alignment. The motor is held by two screws. These fit through holes that are really channels. They are elongated so the motor can be positioned up to 1/4 inch forward or backward. We use this adjustment to correct head misalignment.

To correct head misalignment, load a commercial program disk. If your head is badly out of line, note that the red indicator blinks as the drive misses data and tries again. Use this disk to check the accuracy of adjustments. With the drive off, mark the position of the motor relative to the metal case. A small scratch or pencil mark on both sides of the motor will do. This is important, as you need to know how far you moved the motor and in what direction.

After marking the starting location, loosen the retaining screws slightly. You will have to scrape most of the green glue from around the washer. The washer will not rotate unless it is free.

By observing the location of the marks, rotate the motor clockwise, only slightly, no more than 1/32 inch. Move too far and you may overshoot the track completely. Tighten the retaining screws and try the blinking disk program again. If the blinking has been reduced, you moved in the right direction. If it has gotten worse, repeat but in the other direction.

Once the red light is steady, turn off the drive. Re-tighten the retaining screws and make a final test. Load a disk with error clatter and make sure the clatter doesn't crash the load. If it does, you'll need to adjust the stepper motor again. You should not have to move the motor more than 1/8 inch in any direction. If all else fails, move the motor back to the original starting point and adjust in even smaller increments.

This is not a job for the faint of heart, and you'd better believe it's better than sending eighty-five big ones to Commodore's repair-replace department. Tuning the 1541 is like tuning up a high-powered race car at the Indy 500. But with just a little effort, you can have your 1541 purring like a kitten. ◀CD▶

YOU CAN BUILD THIS MODEM FOR YOUR COMMODORE 64

PART II

JIM STEPHENS

Last month we began a two-part article on how to build this Modem for your Commodore 64. Here is the conclusion of that article.

Circuit adjustment

The most difficult part of the whole project is the adjustment of the circuit for proper operation.

The Commodore 64 can be made to handle many of the chores done by expensive testers and generators. The 64 has a sophisticated sound chip. which we use to set the frequency of our modulator and can use the small program in Listing 1 to check the output of the demodulator. It is not the best alignment method, but it works.

Do not connect the modem to the user port yet. Turn the variable resistors R13 and R14 to the center of their adjustment. These are the timing resistors of the modulator that set the pitch of the two modulator tones. Flip the toggle switch on the modem to ON and you should hear a high-pitched tone coming from the speaker. If not, adjust R11 of the modulator upward and readjust R16 until the volume increases. Keep the volume low or the tone will become distorted. If no amount of adjustment produces a tone, there is probably a wiring error and the circuit needs to be rechecked. Always check the power leads first with a volt meter.

If a tone is being produced, connect test jumper 1 from pin 9 of the 2206 to ground with a small jumper. Notice that the tone changes. Each time ground is touched, the tone shifts frequency. This is the keying input of the modulator and it is this pin that reads the ones and zeroes from the computer. Turn the modem off and connect the modem to the user port. Remember to orient the connector properly. Turn on the 64 and the READY prompt should appear. If it does not, turn the 64 off check all connections on the connector and the wiring of the modem. Always check the voltage levels and their connections first. If the prompt appears, enter the frequency set program shown in Listing 1 and save it. Note that the modem is still off.

LISTING 1

```
 1 REM TEST TONE FOR 2225 HZ
 2 REM F=1070 HZ DATA = 69 114 150
 3 REM F=1270 DATA = 81 94 150
 4 REM F=2025 DATA = 130,67,150
 5 S=54272
10 FOR L=STOS+24:POKEL,0:NEXT
20 POKES+5,9:POKES+6,250
30 POKES+24,15
40 READHF,LF,DR
50 IF HF<0 THEN END
60 POKE S+1,HF: POKES,LF
70 POKE S+4,33
74 END
110 DATA 143,115,150
```

LISTING 1—TONE SETTING PROGRAM for the modulator. Data in line 110 is set to the numbers shown in lines 2 through 4 for the other frequencies as necessary. Data for a 2225 Hz tone is already shown in line 110.

The frequency set program is used to set the tones of the modulator. The small program is initially set up to produce a tone of 2225 Hz using the 64 sound chip. Line 2 through 4 of the program are REM statements that show the data statement changes necessary for the program to produce the other frequencies. Normally, the tones of the modulator will be set to 1070 Hz and 1270 Hz, but first, we must get the demodulator section working before these frequencies are finally set. The demodulator needs to be adjusted to respond to frequencies 2025 Hz and 2225 Hz. To do this, we need to set these frequencies into the modulator first since we will use the modulator section to feed the demodulator when we adjust it.

Run the frequency set program and a tone at 2225 Hz will sound through the TV/monitor speaker. Make sure jumper J1 is not connected to ground and turn on the modem. The tones from the two sources will be quite different. With each tone at about the same volume, adjust R13 (the one that connects to pin 7 of the 2066) until the tones are exactly the same. Listen to the pitch of each at the same time. As the tone of the modulator nears the same frequency of the TV/monitor, the sound will start to rapidly "chirp." This means that the tones are about the same frequency but not exact. Slightly turn variable resistor R13 until the chirps start to slow down to a slow "beat" like a wave of increasing and decreasing volume. The slower the wave, the closer the two tones are. If you have ever tuned a guitar using the fifth fret and listened to the beats, this will be no problem. If you find that all you can get is chirps,

you may be tuning to a harmonic of the 2225 Hz frequency and the tone on the modulator should be raised or lowered. If no amount of adjustment brings the slow beat, you might be tone deaf and should get a friend to help or your variable resistor is too critical and may have to be changed to another with a more even or smoother taper. If you have one, a 10-turn potentiometer works well here. Of course there might be a wiring error. Get the beat as slow as possible and proceed to the next step.

Connect the jumper (J1) to ground. Notice that the tone changed. Turn off the modem with SW1 and the tone on the TV/montor by entering RUN and hitting RUN/STOP quickly. Change the data in line 110 to that shown in line 4 of the program. This is the data that will produce our 2025 Hz tone. Repeat the above procedure while adjusting R14 (the variable resistor that connects to pin 8). Once the slow beat is obtained, you have the modulator tuned as though it were an answering modem. Alternately connect and disconnect J1 from ground and listen to the tone alternate from 2225 to 2025 Hz. We can now use these tones to set the demodulator section.

Tuning the demodulator

Place the modulator speaker near the mike of the demodulator. With the modem on, disconnect J1 from ground. The modulator should be producing a low volume 2225 Hz tone. Place a voltmeter or logic probe on the collector of Q1. The logic level should be high or around five volts. R8 (the volume control on IC3) should be about in the center of rotation. Connect J1 to ground and the output at the collector of Q1 should drop to zero volts. If it does not, vary R7 slowly on the demodulator until it does drop from high to low when ground is touched by the J1 lead. If no amount of adjustment produces this change, readjust the volume control R8 either higher or lower until the modulator locks in with the above adjustment. Once it does, alternately connecting and disconnecting ground with J1 will produce a high and low reading at Q1's collector. A partial low or high on the collector of Q1 is not correct. It must swing all the way to ground and most all the way to five volts. Keep adjusting R8 and R7 until you get the proper swing in voltage level. Don't readjust the timing resistors on the modulator, however, unless you feel the first frequencies could be wrong and you want to start over. Too much volume on the speaker and it could distort the tone being heard by the demodulator. It should work even with the modulator volume quite low. If the level does not change correctly adjust R8 on the LM386 of the demodulator for more drive. If you have one of the modem programs mentioned earlier, you can run it and type into the computer and the response of the modem should print out your typing correctly on the screen. This is yet another method to test the response of the demodulator.

Once the demodulator is responding correctly to the 2225 Hz and 2025 Hz tones, you can reset the modulator (the speaker) to the correct frequencies at which it will operate (1070 Hz and 1270 Hz). This is done with the same procedure as you used in the above example except you change the data in the frequency set program to read as shown in line 2 and 3 of the program. Remember that these tones must be almost exact to work correctly. You could be off as much as twenty cycles and the modem would still work with most answering terminals.

LISTING 2

```
10 OPEN 5,2,3,CHR$(6)
20 GET#5,A$
30 PRINT A$;
40 GOTO 20
```

LISTING 2—SMALL PROGRAM which reads the user port and prints resulting data characters on the screen. There are no ASCII interpretation tables so many of the characters will appear as graphics.

Testing the modem

With the speaker still placed near the mike, enter the small test program shown in Listing 2. Save it and enter RUN. The screen should clear. Then, by rapidly connecting and disconnecting J1 to ground, several graphic and alpha characters should appear on the screen in response to the varying tones. If you have a small modem program, you could call up a friend with an answering modem, insert the phone into the coupler's cups, and have the answering modem type some communications which could be used to check the unit. You can even use the small program in listing 2 but a lot of the data will appear as graphics although some of it can be read with a letter missing here and there.

If you are receiving data over the phone line, it may be necessary to slightly adjust the volume controls and even R7 on the demodulator for the best response. Do not readjust the timing resistors on the modulator however unless you are doing it using the frequency set program as in the above example. The mike's LM386 is not too powerful and the tone on the phone can get quite low. The LM386 amp is at its maximum gain/quality level and a bad connection and low answering volume may not make it through.

If you find that the answering modem is responding correctly to your modulator when you enter data, but the demodulator is not responding to the tone coming in, you probably have too much or too little volume going from the phone to the 2211. Try readjusting the volume control on the mike's LM386 until the data is correctly printed on the screen. Occasional garbage on the screen usually means low volume to the 2211 from the mike's LM386.

If all else fails, an audio tape is available from Syntronics that has all of the tones recorded and a continuous data stream in the answering frequency which can be used to adjust and set your new modem with the use of an audio tape recorder. Details of how to order are given in the parts list.

Above all remember, if it fails to work the first time, you can learn a lot from finding the fault. The feeling of accomplishment you get when it does work correctly is worth more than all the expensive modems ever produced.◀●▶